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THE DESIGNING AND SELECTION OF MIXED MODIFIED CHAIN SAMPLING PLAN WITH VARIANCE CRITERION

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ABSTRACT

Mean is the most commonly used criterion in acceptance sampling inspection by variables, but in many cases, where the variance of the quality characteristics is used as the criterion. Here, a lot may be accepted, if the variance of the quality characteristics is less than or equal to a pre-specified maximum (σ_o^2) value. This paper deals with the new algorithm of Mixed Sampling Plans with Variance criterion. Modified Chain Sampling plan is used in the second stage of mixed plans The Operating Characteristic function and other associated measures of the plan are provided. The algorithm and designing of mixed sampling plan are indexed through standard quality levels. Tables are constructed for easy selection of the plan. Illustrations are also provided.

KEYWORDS: Modified Chain Sampling, OC (Operating Characteristic) Function, AQL(Acceptable Quality Level), First Stage Sampling & Second Stage Sampling

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INTRODUCTION

Mixed Sampling Plan was developed by Dodge and later Schilling (1967) has given a methodology to determine the OC function and its associated measures. Mixed Sampling Plan has two stages. In the first stage inspection is done with variable criteria and the second stage with attribute quality characteristics. In a Mixed Sampling Plans, the second stage of attribute inspection becomes more important to sentence the lot, if the first stage variable inspection fails to accept the lot. In the second stage, acceptance number of zero plans is more emphasized for practical reason. Hence in the second stage, modified chain sampling plans are recommended. The resulting plans give small samples in both the stages. DevaArul (2004) has developed Mixed Sampling plans and Reliability based Sampling Plans DevaArul (2009) has contributed towards mixed sampling system with tightened inspection in the second stage. Suresh and DevaArul (2002) have developed mixed sampling plans by combining process and product quality characteristics to reduce the sampling cost. Dodge E.G (1955) has developed 'Chain Sampling Inspection Plan'. Govindaraju and Lai (1998) have developed modified chain sampling plans for costly or destructive items. Suresh and DevaArul (2003) have developed mixed sampling plans for Maximum Allowable Variance. Edna (2012) has made, a study and contributions to quality control measures based on acceptance sampling plans. DevaArul S and Edna (2011) developed, Mixed Sampling Product Control Plans for Costly or Destructive items.

FORMULATION OF THE MIXED PLAN

The development of mixed plans and the subsequent discussions are limited only to the known variance (σ^2). The mixed sampling plan with variance criterion can be formulated with four parameters N_1, N_2,K,I.

Where,

N_1= first Sample Size

N_2= Second Sample Size.

K = predetermined variable value

I = index of chaining the lots.

ALGORITHM OF MIXED PLAN USING VARIANCE CRITERION

Step 1: Identify the four parameters, with reference to OC values..

Step 2: Take a random sample of size n_1 from the lot assumed to be large.

Step 3: If the sample variance ratio $\frac{s^2}{\sigma_0^2} \leq K$, accept the lot.

Step 4: If the ratio $\frac{s^2}{\sigma_0^2} > K$, take another second sample of size N_2.

Step 5: Inspect and count the number of defectives 'D' in the second stage.

Accept the lot if

- The current sample as well as the preceding 'I' samples contain no defective units.
- The current sample contains no defective units, while any one of the 'I' preceding samples contain only one defective unit and the rest of (I-1) samples are free from defective units. Otherwise reject the lot.

Measures of the Independent Mixed Sampling Plans

- **Probability of Acceptance**

$$P_a(p) = P_{N_1}[(\frac{s^2}{\sigma_0^2} \leq K)] + P_{N_1}[(\frac{s^2}{\sigma_0^2} > K)]P_0(P_0^I + IP_0^{I-1}P_1),$$

Where,

$$P_0 = e^{-N_2 p} \text{ and } P_1 = N_2 p e^{-N_2 p}$$

Hence $P_a(p) = P_{N1}[(\frac{s^2}{\sigma_0^2} \leq K)] + P_{N1}[(\frac{s^2}{\sigma_0^2} > K)]\ e^{-N_2 p(I+1)}(1 + IN_2 p)$

- **Average Sample Number** ASN= $N_1 + N_2 P_{N1}[(\frac{s^2}{\sigma_0^2} \leq K)]$

- **Average Total Inspection** ATI=ASN+(N–N_1–N_2) (1 – P_a(p)) ,N is the lot size

- **Average Outgoing Quality** AOQ=p.P_a(p) for any lot of large size

Designing and selection of mixed plan, indexed through AQL, if the first stage sample size $N_1$is known.

Procedure

- Assume that the plan is independent.
- Split the probability of acceptance that will be assigned to the first stage. Let it be B_1 respective to p_1 such that $B_1 \geq B_1'$
- Fix the sample size N_1 to be used. Obtain S^2,the sum of the squares from the sample observations.
- Calculate the variable factor K by using the equation

$$\alpha = P\left(\frac{S^2}{\sigma_0^2} > K\right) = \int_{\frac{K}{\lambda}}^{\infty} f(z)dz$$

Where, $\lambda = \frac{\sigma^2}{\sigma_0^2}$ and z follows chi-square distribution with n-1 degrees

- Find β_1'' the probability of acceptance assigned to the attribute plan associated with the second stage sample as

$$B_1'' = \frac{B_1 - B_1'}{1 - B_1'}$$

- Determine the appropriate second stage sample of size N_2 for the known index I from the equation

$$e^{-N_2 p(I+1)}(1 + IN_2 p) = B_1''$$

The solutions of the above equation are got by using an iterative procedure. A computer program is used to solve the equation and to construct the tables

Table 1: The Values of Variable Factor K and the First Stage Sample Size N1 for Known B1 = 0.99 and B1'= = 0.95

N_1	K		N_1	K
6	12.59		22	33.92
10	16.92		26	38.88
15	24.9		28	41.37
16	26.9		29	46.93
18	28.86		30	47.92

Table 2: The Values of the Stage 2 Sample Size N2 for the Known AQL (Using Modified Chain Sampling Plan as Attribute Plan). B1=0.99, B_1'=0.95.

P_1	Stage 2 Sample Sizes N_2			
	I=1	I=2	I=3	I=4
0.001	64	61	57	54
0.0015	53	52	50	49
0.002	47	45	43	41
0.0025	38	36	34	33
0.003	31	28	26	24
0.0035	23	21	19	18
0.0040	16	15	14	13
0.0045	11	9	8	8
0.005	8	8	8	8
0.006	7	7	7	7

Illustration

In a production process, it is given that AQL 3%, $B_1 = 0.99$, first stage sample size $N_1=15$ and i=3. Find the mixed sampling plan with variance criterion.

Solution

Let the stage 1 sample size be $n_1 = 10$

Given $B_1 = 0.99$ and the stage 1 probability of acceptance, $B_1^{'} = 0.95$

From the above Table (1), the variable acceptance factor is K=24.91

The stage 2 probability is 0.8. From Table 2, the stage 2 sample size is 26 for I=3.

CONCLUSIONS

In this article, a new algorithm to sentence the lots in mixed quality characteristics with variance criterion is presented. Designing procedure and tables are given for easy selection of the plan. For attribute inspection, modified chain sampling plan is used in the second stage, which, yields small sample sizes. Hence a producer can save inspection time and inspection cost.

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